SECTION 12

BRIDGE DECK REPAIR DESIGN GUIDELINES

The following guidelines shall be common to most deck repair projects. These guidelines should be used to avoid common problems during plan preparation and construction. All items in these guidelines may not be applicable or appropriate for every project. However, any deviations from these guidelines should be discussed with the NJDOT Project Manager in charge of the project.

The purpose of Bridge Deck Repair projects is to construct interim repairs which can provide a smooth riding surface and improve the bridge deck surface and bridge deck joints so as to extend the useful life of the structure in a cost efficient manner.

1.12.1 FIELD RECONNAISSANCE

All field work shall be conducted with safety as a first priority. All field personnel are to wear safety vests. Lane closures are not permitted without proper approval of the Department's Project Manager. Designer's vehicles shall not be parked in the shoulder unless proper cones and signs are placed.

A. Plan Preparation For Field Edit

1. As-built plans of the bridge should first be obtained from the Department.

2. Prior to field reconnaissance, a plan view of the deck should be drawn at a scale of 1:50. A grid system at 1.5 m intervals should be drawn on the plan to enable easy recording of deck defects.

3. Accident data within the vicinity of the structure and approaches should be obtained and reviewed for safety upgrades.

B. Traffic Patterns

1. Traffic patterns should be reviewed in the field. Sketch and make a note of all warning and regulatory and guide signs within the vicinity of the structure in question. Indicate posted speed limit.

2. The number of lanes and shoulders at each bridge approach and on the bridge itself should be noted. Make notations and measurements of all striping transitions especially where lanes are dropped or added or where shoulders are dropped or added. All existing lane widths shall be measured.

3. Show all ramps within the vicinity of the bridge structure whether they are immediately adjacent to or located within 450 m of the bridge structure in question. Measure the distance to the ramp from the structure.

4. Concrete barrier curb widths should be measured to determine if signs could be mounted. Caution should be exercised and traffic approval is required when

requiring signs to be mounted on concrete barrier curb. Possible insufficient shoulder width and resulting traffic interference problems should be evaluated.

C. Deck

1. Verify Base plans to insure that no changes have been made to the deck since the as-built plans were prepared. Any changes made should be measured and incorporated into the plans.

2. A baseline which follows the grid sequence on the deck plan should be placed in the field with stations marked at 3 m intervals. Photos and/or video of the deck should be taken for future reference. A dry marker board of paper medium can be used as a photograph location reference.

3. The defects should be recorded by sketching the defects. Areas of previous repair as well as existing spalls should be sketched. A proper legend should be developed to symbolize each defect.

4. The concrete decks should be tested to determine the deteriorated areas as follows:

Tier I	Sounding (chain drag and hammer methods)
Tier II	Deck condition survey & evaluate the latest bridge inspection report

Refer to 1.12.2(B) for the definition of Tier I and Tier II.

- Evaluate the bridge inspection report to verify the appropriate Tier ranking.

- Perform a full deck condition survey with criteria as specified in Section 9C of this Manual.

Before proceeding with the Tier II measures, the following guidelines should be evaluated.

- The current Bridge Evaluation report should be evaluated by the Designer since a Federal Funded Tier II repaired bridge can not be repaired again using Federal Funds for a period of 10 years.

- A full deck condition survey, following the criteria as specified in Section 9C of this Manual, should be performed.

5. To avoid underestimation of quantities, the sounding of the deck to detect areas of delamination should occur close to the time of the actual project construction. A typical probable time line for advancing Bridge Deck Repair Contracts should be as follows:

- July to November - Bridges selection
- September to February - Deck condition surveys
- November to March - Complete all plan sheets
- March to April - Advertising
- April to May - Award
- Completion in no more than one construction season

Deck condition surveys will be performed by trained construction personnel or vendors prior to advertisement of the Project.

6. To categorize asphalt overlaid decks into Tiers I and II, visual inspection, study of past Bridge Evaluation reports and of maintenance history and use of Department approved delamination detection devices shall all be utilized to determine the deteriorated areas. Existing Tier I asphalt overlaid decks will not be included in the Deck Repair Program as they are not cost effective.

7. Traffic control by Maintenance staff should be arranged with the Director of Operation's Office. If manpower is not available, a consultant agreement to perform deck soundings, including the traffic control, must be entered into.

8. The Designer shall evaluate the underside of the deck slab for potential full depth repairs, or to check the condition of stay-in-place forms.

D. Joints

1. Deck joint type, size and locations should first be confirmed against as-built drawings. Joint spalls should all be recorded. The joint filler material should be observed for any deterioration. The existing width of the joints shall be noted. The ambient temperature and general weather conditions during these observations should also be noted.

2. The joints shall be observed under the structure to determine if there are any water stains, efflorescence or spalls on the substructure due to joint leakage.

1.12.2 PLAN PREPARATION FOR DESIGN

A. Key Sheet

1. The Key Sheet shall be submitted prior to Final Design so that the proposed titles, control section number, and highway types can be reviewed. The title to appear on the Key Sheet shall be:

Bridge Deck Repair
at Various Locations
Contract No. # VAR970199
Route # _____
From The Vicinity of Route # _____ to Route # _____

2. Counties where each bridge is located shall be shown above the Key Map. The location of each bridge shall be flagged off on the Key Map and labeled "Project Site 1", "Project Site 2", etc. The "Project Site" numbers shall correspond to the numbers on the chart labeled "Bridges in this Contract" appearing on this sheet. At locations where all bridges can not fit on the same Key Map, another Key Map shall be shown to the right of the main map with the remaining project sites flagged out.

3. The total length of the project to be shown on the Key Map shall be 0 meters or 0 kilometers because of discontinuity between sites. Also, on the BRIDGES IN THIS CONTRACT Table, add a column for Total Bridge Length for each bridge for FHWA FMIS Reporting purpose.

4. Any utilities affected by construction shall be shown on the Key Sheet. If none are affected, then the list of utilities shall be removed from the Key Sheet.

B. Repair Percentage

1. The maximum percentage of deck patching areas that should be included in these projects and remain cost effective are as follows:

1% to 30%	deck deterioration	Deck Patching	(Tier I)
20% to 60%	deck deterioration	Deck Patching with overlay	(Tier II)
50% to 100%	deck deterioration	Deck Replacement	

The overlapping percentages are intended to provide some flexibility in the decision making process. If the deck deterioration percentage falls in the overlapping percentages, then the following factors should also be considered in order to place the bridge in the appropriate tier:

- *Adjacent Structure* - Need to look at the condition of and what repair work is proposed for the adjacent structures in the corridor.
- *Upcoming Project* - If the bridge is included in a project that is in the pipeline.
- *Traffic Volume* - ADT in the heavy traffic areas.

2. When the deck deterioration percentage indicates that the deck should be replaced, it should be programmed in the pipeline as soon as possible so that its construction can begin within 2 years. Accordingly, performing deck repairs is not economical. If warranted as a temporary measure, asphalt patching with an

asphalt overlay will be utilized (if the bridge can take the additional load) until the bridge receives a new deck.

C. Estimate of Quantities

1. All roadway and bridge items shall be shown in the same estimate of quantities sheet. Bridge items shall follow all roadway items. Each bridge shall be listed by name and bridge number above it's quantities.

2. If a pay item other than those of Section 500 of the Standard Specifications is used for work on a bridge, then that item shall be listed with the roadway items and will be cross referenced on the bridge drawings.

3. Current Baseline Document Change (BDC) memorandums shall be followed for standard items and standard item numbers that are to be included in the contract. In addition, all projects shall include items for:

   - Final Cleanup
   - Construction Layout
   - Field Office
   - Telephone Service
   - Dust Control Calcium Chloride
   - Clearing Site

4. The estimated area of patching should be provided for each structure in the contract. However, these quantities will be added and included under one pay item.

D. Roadway Construction Plan

1. All roadway items shall be shown on a "Construction Plan". No bridge items shall be shown on this plan. The sheet shall contain a plan view of the bridge with predominant features of the structure shown. Multiple bridges are permitted to be detailed on the same plan sheet with the appropriate scale shown below each detail.

2. Sheets shall be prepared so that each roadway construction item is labeled with a bubble containing the "Standard Item Number" with an extension line showing the required quantity. Label and dimension all lane widths, shoulder widths, high type channelization devices such as concrete islands, concrete medians, etc.

3. Label each plan view and route number, direction and structure number (e.g. Route 15 SB over Main Street (1404-151)).

4. Provide a "To Be Constructed" table which includes Pay Items No., Std. Item No., To Be Constructed (description) and Contract Quantity.

5. A table shall also be shown providing a cross reference to the appropriate bridge sheets.

6. Like quantities for each bridge must be flagged individually but can be summed together in the “To Be Constructed Box.”

E. Staging Plans

1. Prior to developing staging plans, the Project Manager shall contact Traffic Operations to determine what are the maximum allowable lane closure hours in each direction and the maximum number of lanes that can be closed at one time. When work is to be done on local roads, local authorities should be contacted to determine if they have any restrictions regarding lane closures. A minimum ten hour window is required for the Contractor to properly complete his work. If Traffic Operations does not have allowable lane closure hours across a ten hour window, then the Project Manager shall recommend a revision to these hours to Traffic Operations based on field observations made at the beginning and end of the lane closure hour window.

2. Staging plans shall show a cross-section of the bridge for each stage of construction (two stages are preferred). In each of the planned stages, repair areas shall be distinguished from travel lane areas. Placement of traffic control drums with dimensions of temporary travel lane widths and repair area widths shall be shown. Reference notes to cross reference traffic control plan sheets and deck repair plan sheets shall also be shown. A table of allowable lane closure hours must be provided on the plan.

   A note must be placed in the specifications stating that the Contractor must pay liquidated damage costs for time spent on the construction site prior to or after the hours stated in the “Allowable Lane Closure Hours” table. In addition, minimum work area widths, overall bridge width, minimum lane widths, and existing cross slopes shall be indicated.

F. Traffic Control Plans

1. A set of applicable standard traffic control plans shall initially be obtained. These plans are only to be used as a basis for developing the final traffic control plans. These plans shall be customized to reflect site conditions such as complex ramp striping locations and the ability of the shoulder to withstand traffic.

2. Plans must comply with NJDOT, MUTCD and AASHTO regulations.

3. All nonstandard signs shall be sized according to the MUTCD with letter heights and alphabet size given for each line.

4. All traffic control schemes and detour plans on local roads, if applicable, must be approved by local authorities. It is important that early in the design a set of applicable traffic control and staging plans be sent to them for their approval. A letter of approval from any of the affected local authorities must be included in the final design submission.

G. Construction Details

Bridge Construction Detail (BCD) sheets 1A, 1B, 1C and 1D can be referred to for typical details that shall be used in contract plan development.

H. General Plan and Section

1. This sheet shall include a plan view of the bridge, a key plan, a typical cross section, a baseline, an existing profile (if surveyed for Tier II project), a proposed profile if it is different from the existing profile, general notes, an index of drawings, and a summary of quantities. If no new design survey was performed for a Tier II project, the Contractor must be required to do the survey prior to scarification.

2. The plan view shall be developed from as-built plans and modified as per the field reconnaissance. All roadways should be labeled with the lanes dimensioned. The deck joints, parapets, utilities, sidewalks and curbs shall be shown.

3. The bridge section shall show a typical cross section of the superstructure with the existing lane and shoulder configuration, the cross slopes, deck slab thickness, rebar location and the typical extent of deck repairs.

4. General Notes shall list reference specifications and any other pertinent notes for the contractor.

5. The “Index of Drawings” shall contain the bridge sheet numbers of the drawings pertaining to that structure.

6. The “Summary of Quantities” shall contain only bridge quantities for that particular bridge. All other quantities shall appear on the “Construction Plan” and/or the “Estimate of Quantities” plan.

I. Deck Repair Plan

1. This sheet shall contain a plan view of the deck at a scale of 1:50. The plan view shall be drawn from As-builts and edited as per the field reconnaissance. A grid at 1.5 m intervals shall be drawn over the deck to facilitate spall locations. Locations of lane lines shall also be shown.

2. All existing spalls and areas of previous spall repairs as well as other proposed repair areas shall be shown on the plan via the symbols contained in a legend. Deck joints to be repaired or reconstructed shall also be indicated with references to the Deck Repair Details. This is to calculate the percentage of deteriorated deck area and show a true As-Built condition of the deck surface.

3. The notes should contain page numbers of all the cross referenced sheets, including Traffic Control Plans, Staging Plans, Roadway Construction Plans and whether stay-in-place forms exist under the deck.

4. Decks with asphalt which are to be resurfaced shall have a quantity of “Concrete Deck Repair” based on the existing condition of the asphalt, the structure’s age, the

volume of traffic and deck condition survey. Deck areas 1.5 m from the both gutter lines shall be assumed to be deteriorated.

J. Deck Repair Details

1. These sheets shall show typical repair details. The method of repair to be as per the NJDOT Standard Specifications for Road and Bridge Construction.

2. Repair procedures that the Contractor will follow should be outlined in the notes.

3. Details should be shown for a temporary cover of the repair areas that are not completed during work hours.

4. Once the quantity of deck of repair is computed, ***5%*** of this area for "if and where directed" quantities is to be included in the total quantity.

5. For small areas of repair, reinforcing bars shall be replaced "in kind". For large area (> 2 square meters), all new reinforcing bars shall be epoxy coated.

6. Deck repair details shall reflect the as-built plans. For example, special deck repairs shall be included for deck slabs which have truss reinforcment bars

7. Full depth repairs are required when any portion of the bottom layer of reinforcing bars is exposed.

K. Deck Joint Reconstruction Details

1. These sheets shall show typical repair details for deck joint reconstruction for specific field condition; such as, abutment headers or approach slabs as well as deck joints at the abutments and piers.

2. All as-built plans for the deck joints should be thoroughly checked and field verified prior to designing the repair.

3. It is imperative that the correct size be given for the elastomeric joint sealer in order to avoid problems during construction where the elastomeric joint sealer is to be replaced. Staging of this installation should also be specified.

4. If joint spalling is limited and marginal in width and depth, consider vertically saw cutting the deck joint and providing new wider joint filler material curb to curb.

5. The measured quantities of Deck Joint Reconstruction will be the sum of the overall length of each side of the individual joint reconstructed. Notes to call for this measure shall be shown on the plans.

6. For Tier II projects, armoring of deck joints should be considered based on deterioration of the deck slab edges and heavy truck traffic.

L. Quality Control

1. A cross check must be made between the Staging Plans, GP&E, Deck Plans and Roadway Construction Plans for items including but not limited to existing lane widths and any other existing features.

2. In addition, a cross check must be made between the details on the Roadway Construction Plans, and the Structural Plans to ensure constructability and prevent the overlapping of items. Areas outlined for spall repairs should be checked against the field photos to insure that the areas have been outlined properly.

M. Bridges over Railroad Tracks

1. All repairs over a Railroad will require Liability Insurance as specified in the Special Provisions.

2. Temporary shielding will not be required on decks having Stay in Place Forms or decks over abandoned railroad tracks. In addition, temporary shielding will not be required if the Designer decides that there is no possibility of full depth repairs over railroad tracks or other locations where there is no potential harm due to falling concrete. The Designer will verify the need for temporary shielding.

3. If temporary shielding is not anticipated, the pay item “Temporary Shielding - Working Drawing” (Lump Sum) should be included in the plans and specifications to provide for emergency conditions.

4. If temporary shielding is required, the following items should be included in the plans and specifications:

   a) Temporary Shielding - Working Drawing (Lump Sum)
   b) Temporary Shielding (SM)

5. Flagman and inspectors and other associated costs will be as provided for in the Utility Agreement.

6. The use of temporary shielding after the approval of the working drawing will be at the discretion of the Resident Engineer.

1.12.3 CONSTRUCTION TECHNIQUES

A. Approaches

1. A bridge which has an asphalt approach roadway and has an abutment deck joint that should be replaced shall have the approach milled a minimum distance of 3 m, a tack coat applied, and a minimum of 50 mm of Bituminous Concrete Surface Course Mix I-4, Aggregate Modified, constructed on the approach. This will result in a smooth transition from the slab to the deck.

2. The length of approach to be milled and resurfaced is dependent on the pavement condition of the approach and any excessive differences between the elevations on the approach and bridge deck. A minimum length of 3 m should be used.

B. Deck

1. Bituminous concrete overlays are not permitted on any bridge decks. In special cases where such overlays are already part of the existing deck surface, replacements of such overlays may be appropriate. Placements of these overlays will be approved on a case by case basis by the Manager, Structural Engineering. In any event, milling of asphalt overlays will not be permitted on any bridge deck unless shown on the plans. Bridges requiring resurfacing shall use the roadway item "Removal of Bituminous Concrete Overlay".

   After patching the deck, a waterproofing membrane shall be applied prior to resurfacing the bridge with "Bituminous Concrete Overlay Mix I-4, Aggregate Modified". The item "Water Proofing Membrane" shall only appear on the bridge plans. Other roadway items shall only appear on the Construction Plan.

2. In order to reduce construction costs, repair of deck deterioration of all the bridges in the contract shall go under the single non-standard item "Concrete Deck Repair". The Designer will provide specifications for this item. The item will consist of constructing a modified standard "Type B" repair for all repairs. However, if a "Full Depth" repair is encountered, it shall be repaired as a full depth repair, but still be included in the item "Concrete Deck Repair". Class A concrete or Type IA quick setting patch material is to be used for concrete deck repairs depending on available traffic windows. For depths more than 100 mm, patch materials and method of construction shall be approved by the Resident Engineer. Special attention should be made to manufacturer's recommendations regarding application thickness and curing time.

3. All spall areas to be repaired must be clearly outlined on the plans. All previous spall repairs containing epoxy shall be removed if an LMC overlay is planned. It has been determined that it is more practical and efficient to group together small spalls and outline it as one large spall repair. Engineering judgment should be used to determine if small isolated spalls in the deck should be included as part of an adjacent larger repair. The larger the repair patch, the easier it is for workers to remove the defective concrete and replace it with patch material.

4. All deck repair shall be finished utilizing a coarse broom finish unless the existing deck is already sawcut. This item is to be included in the price bid for the item "Concrete Deck Repair". Large repair areas such as overall lane widths or decks already sawcut shall be finished with the item "Sawcut Grooved Deck Surface".

5. Construction joints are often used to limit the size of the repair due to lane closing restrictions. They may also be placed at the contractor's option to provide a working edge for concrete finishing, to provide for a continuous joint replacement, or at the end of the work day. Extreme care must be made to remove all loose

materials (new or old) along these construction joints prior to placing any new concrete.

There is a tendency to have irregular shapes at the interface between deck patches and joint reconstruction. This is due to the skew angle between the direction of the traffic lane and the joint. This results in acute angles. The newly placed concrete can crack in these areas. The designer should avoid these problems by outlining repair areas that do not form acute angles with the deck joints or other repair areas. There may be cases where new construction joints must be sawcut into the new concrete to provide the proper edge. Notes on the plans should instruct the contractor to plan his work to avoid placing a construction joint at odd angles.

6. Notes on the plans should outline repair procedures. All existing reinforcing steel must be sandblasted or hydroblast cleaned prior to placement of patch material. The minimum depth of repair should not be less than 50 mm with a minimum of 25 mm removal of concrete below the bottom of the top mat of the existing reinforcement. In all cases, there should be enough space available for the maximum size of concrete aggregate to "fit" in any location within the volume of the repaired concrete deck.

   The plans must be specific about the concrete removal. Hydrodemolition is acceptable as a removal technique. The Contractor must provide necessary sediment control measures so as not to impact any surrounding areas or drainage systems and meet all environmental requirements.

7. Details must be shown for treatment of repair areas which can not be completed during work hours due to unforeseen conditions. The most widely utilized method is to fill the spall with cold patch. In addition, a detail utilizing a steel cover plate should also be shown. The contractor should have the option of what method to use. A time limit of 2 days should be placed on the duration the temporary cover can remain in place. The price for placement, maintenance, and removal of the temporary cover and cold patch during repairs shall be included in the bid cost of "Concrete Deck Repairs".

8. An LMC or Silica Fume concrete overlay should be constructed where feasible. Due to the curing time of 14 days, a lane or bridge closure is required. When specifying an overlay, it is important for the designer to recognize that the deck joints and approaches may have to be reconstructed due to the elevation change.

C. Joints

1. Deck joints which exhibit leakage and/or edge spalling shall be repaired by replacing the Deck Joint Sealer and/or reconstructing the header and/or deck side of the joint utilizing the non-standard items "Deck Joint Reconstruction", "Sawcut Joint Reconstruction" or "Deck Joint Repairs". These items shall be measured in

linear meters with the area to be repaired outlined in the plan view. Generally, it has been found that it is more practical to repair the entire length of joint thereby creating a better seal of the preformed elastomeric joint sealer rather than only repairing a portion of the joint. All labor and materials shall be included in this item except for preformed elastomeric joint sealer which shall be itemized separately.

2. Where applicable, hot poured rubber asphalt joint sealer should be used to seal joints. Where possible, bituminized fiber joint filler should be placed below the hot poured rubber asphalt joint sealer.

3. Where defects due to spalling at joint sealers occur, the joint should be repaired according to appropriate details.

4. Where abutment deck joints are reconstructed, hot poured sealant should be placed between the abutment header and approach slab.

1.12.4 SAFETY UPGRADES

Safety upgrades will not be included as part of the deck repair project but will be included in a subsequent contract. This contract will be authorized and advertised no later than 12 months following the completion of the deck repair work so work can begin promptly ***after*** the deck repair contract work is completed. Safety upgrades guidelines will be as follows:

A. For decks receiving a concrete overlay:

1. All geometric standards will be met, or a design exception will be prepared.

2. Upgraded safety features that will be incorporated on NHS bridges receiving a concrete overlay will include crashworthy attachments and transitions of approach beam guide rail to the bridges, installation of guide rail or other crashworthy retrofit barrier system across the structure, or installation of replacement of parapets. For non-NHS roadways, if full safety upgrades are not practical, as determined by the Bureau of Structural Engineering, and there is no accident history, then attachments and transitions which consist of at least reduced post spacings and connections with a history of satisfactory performance will be considered acceptable.

B. For decks that are to be patched between **20%** and **30%** of the total deck areas:

1. In addition to approach guide rail being attached to the bridge using a crashworthy attachment and transition, the need to upgrade or retrofit the existing bridge rails will be evaluated on NHS bridges. Factors such as accident data, loading, geometry, cost and impact of the improvement will be evaluated, and any decision not to upgrade or retrofit the existing bridge rails will be justified and documented in the bridge design project files.

2. For non-NHS roadways, if full safety upgrades are not practical, as determined by the Bureau of Structural Engineering, and there is no accident history, then

attachments and transitions which consist of at least reduced post spacings and connections with a history of satisfactory performance will be considered acceptable.

C. For decks that are to be patched to less than **20%** of the total deck area:

1. If there is no accident history, attachments and transitions which consist of at least reduced post spacings and connections with a history of satisfactory performance will be considered acceptable.

2. Attachments and transitions not meeting this criteria will require upgrading to current standards. Existing approach beam guide rail will be attached to the bridge using an acceptable attachment.

D. Bridges with aluminum 3-rail bridge railings with an adjacent brush curb of 230 mm or less, will not be retrofitted, unless there is a history on unsatisfactory performance.

E. A brief statement addressing resolution of safety deficiencies will be provided with authorization requests for projects.

1.12.5 NBI CODING

A. For decks receiving a concrete overlay, item 106 (year constructed) of the Structural Inventory and Appraisal will be updated to the year of reconstruction. The highest code that is used for a reconstructed deck is an “8”. The coding of Item 58 (bridge deck condition) will be based on the actual condition of the deck in the field, but in no case less than a rating of “7”.

B. For decks receiving patching, item 106 will not be revised and the coding of Item 58 will be updated based on the actual condition of the deck in the field.